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Crispin

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(54) **LOCKING ADJUSTMENT DEVICE**

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(52) **U.S. Cl.**
CPC ... ***F41G 1/38*** (2013.01); ***F41G 1/16*** (2013.01)

(58) **Field of Classification Search**
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USPC 42/119–120, 122; 359/399, 421–432, 359/503, 505
See application file for complete search history.

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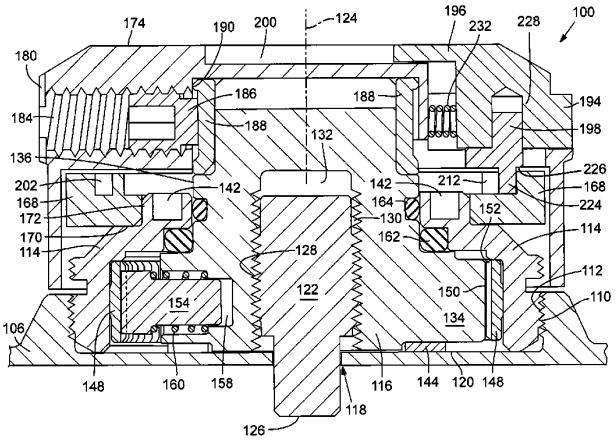
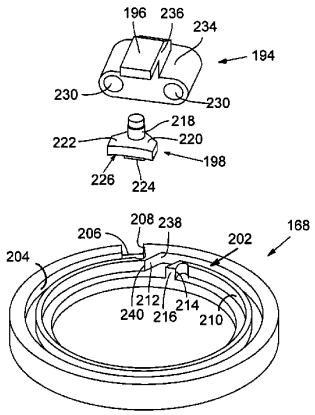
(57) **ABSTRACT**

A locking adjustment device for changing an adjustable setting of a device such as a riflescope locks in a baseline position to provide expedient feedback regarding an adjustment position of the adjustable setting. The device includes a guideway extending around an axis and a knob mountable over the guideway for rotation about the axis. The guideway includes a notch and a curved slide surface sized to slidably receive a guide tab carried by the knob. The guide tab is biased so as to urge at least a portion of the guide tab into the notch when the knob is rotated to a locked position, thereby preventing inadvertent rotation of the knob from the locked position. A button carried by the knob is depressible to urge the guide tab out of the notch and thereby allow the knob to be manually rotated away from the locked position.

18 Claims, 6 Drawing Sheets





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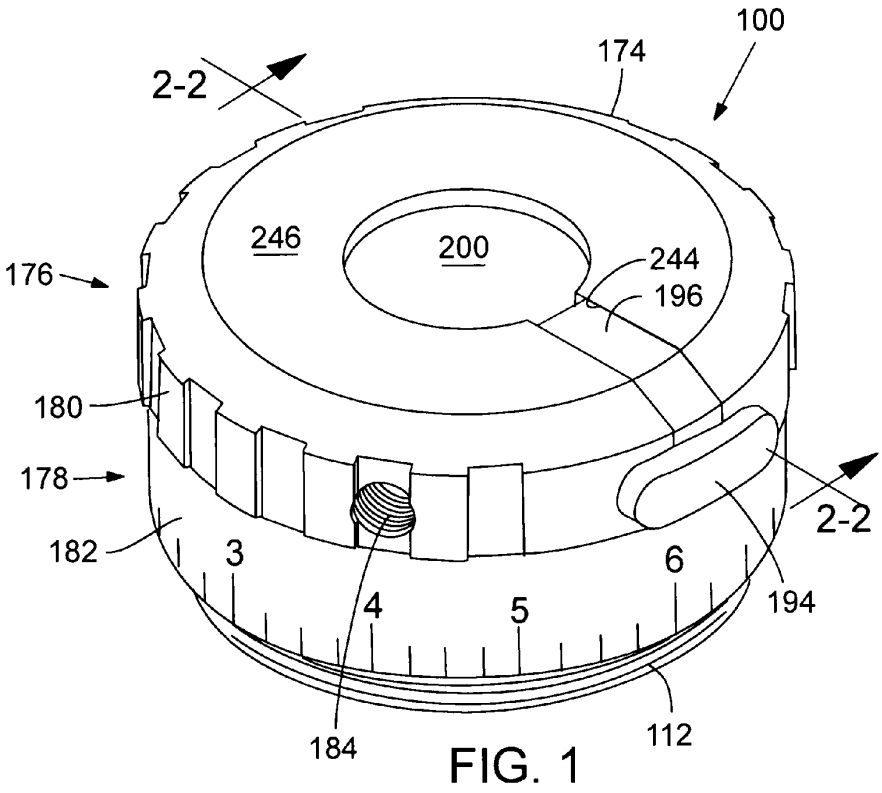

FIG. 1

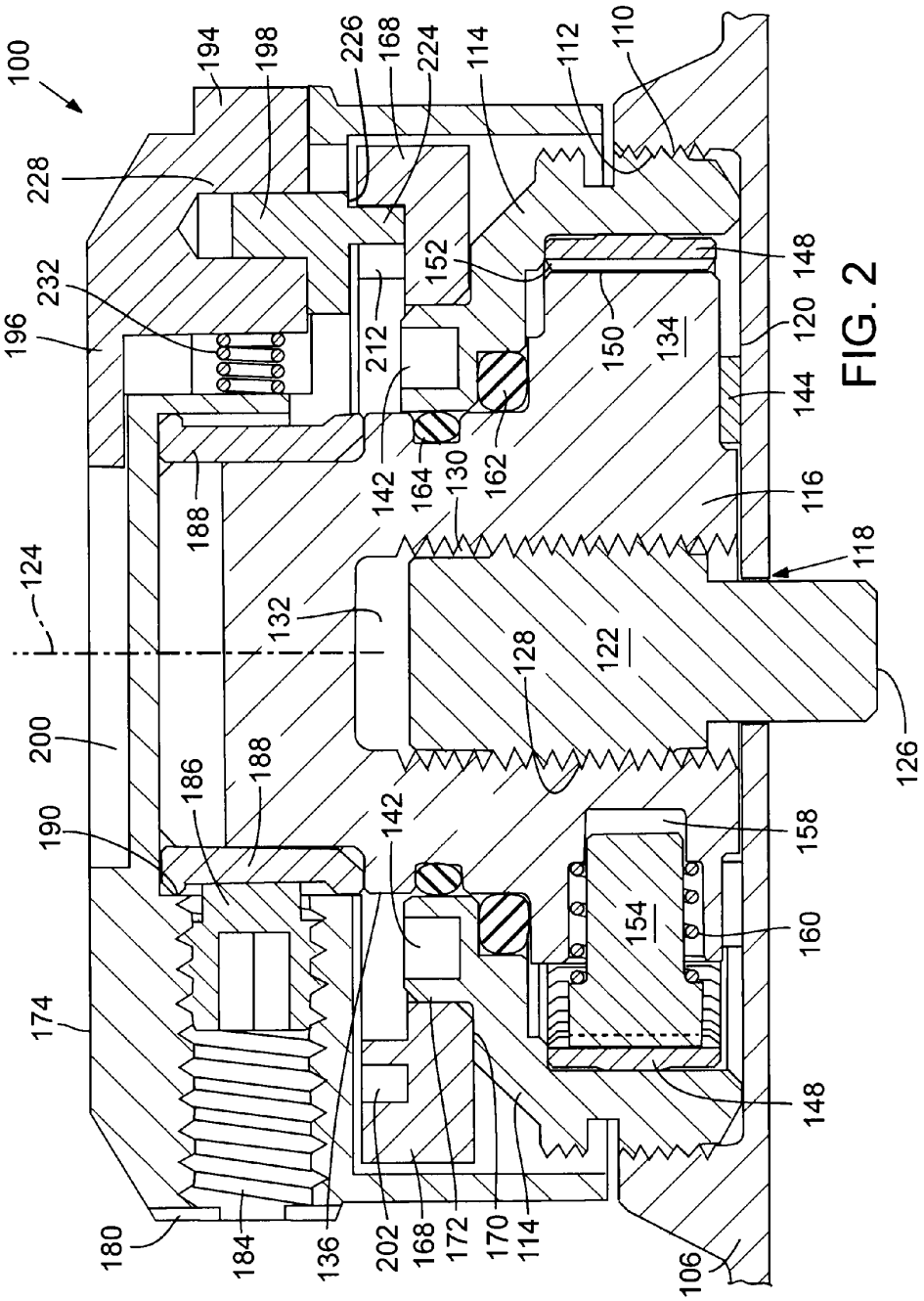
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FIG. 2

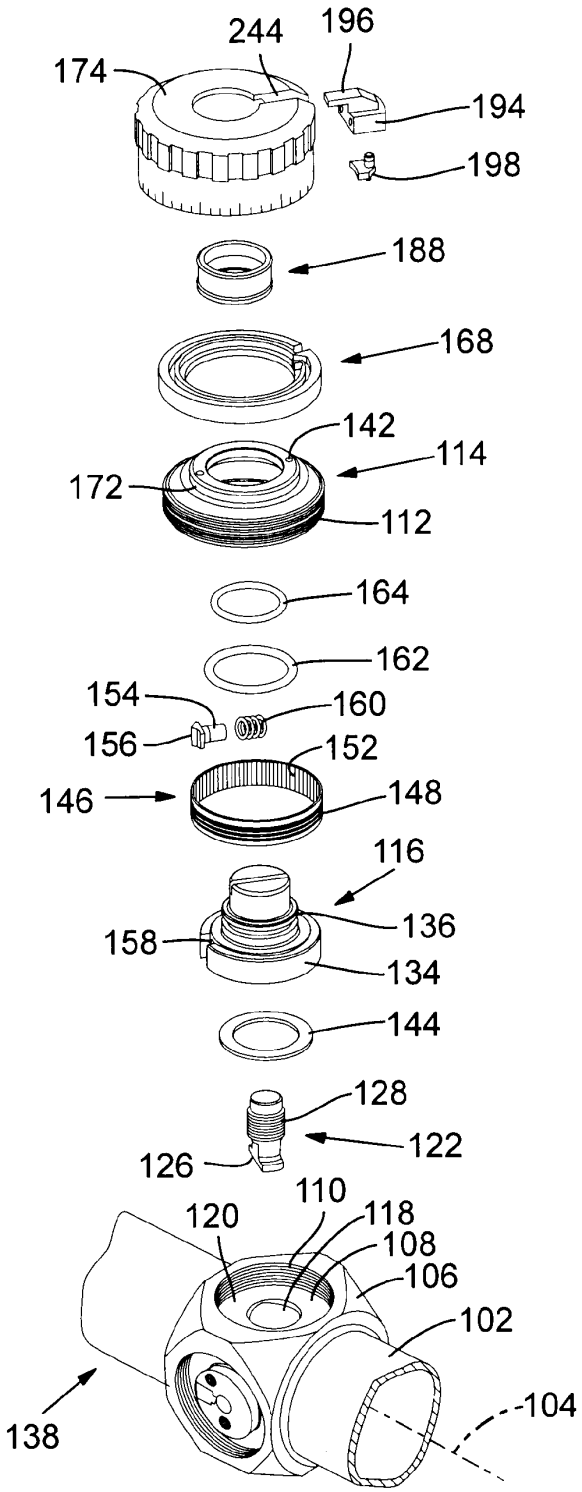
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FIG. 3

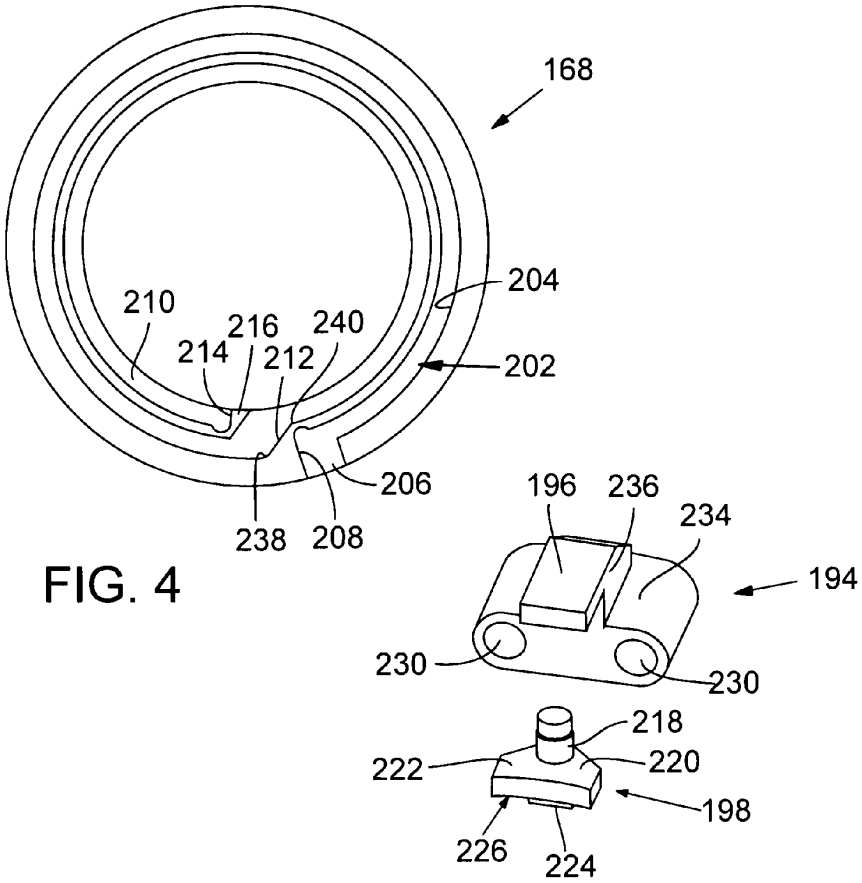
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FIG. 4

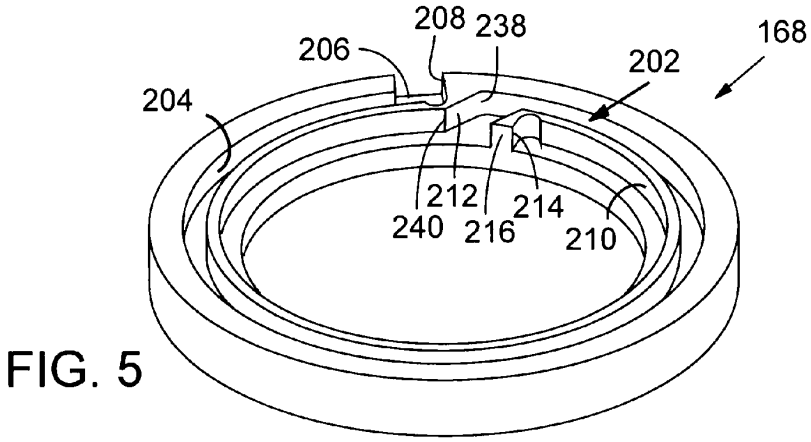
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FIG. 5

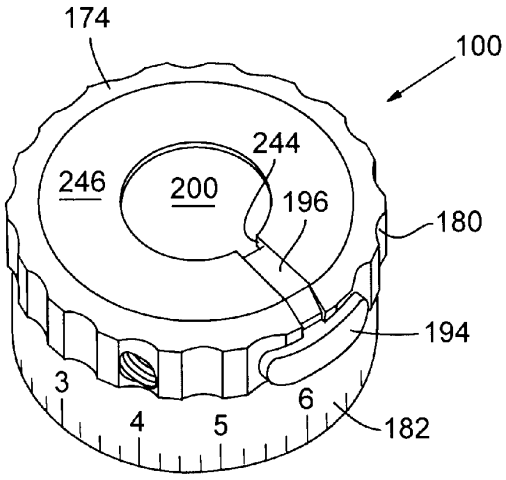

FIG. 6A

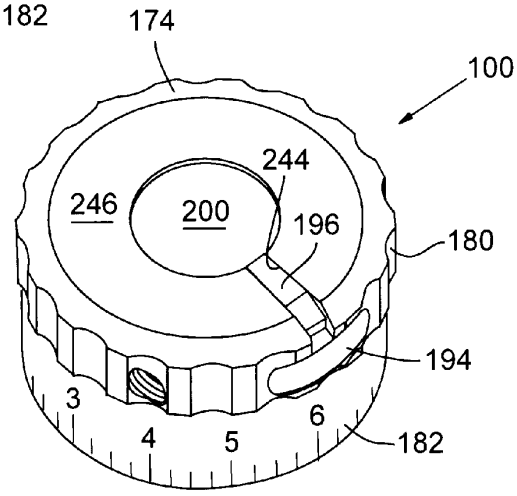

FIG. 6B

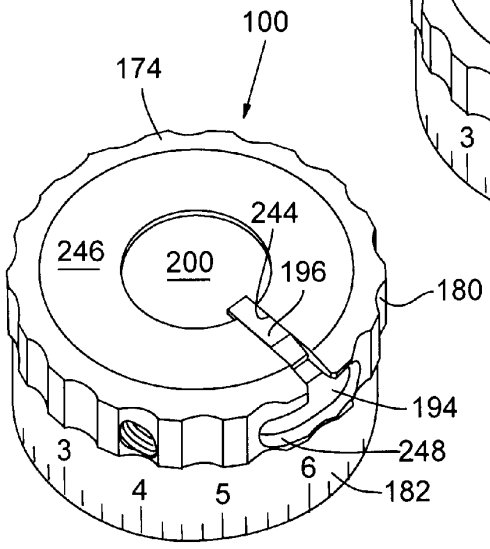

FIG. 6C

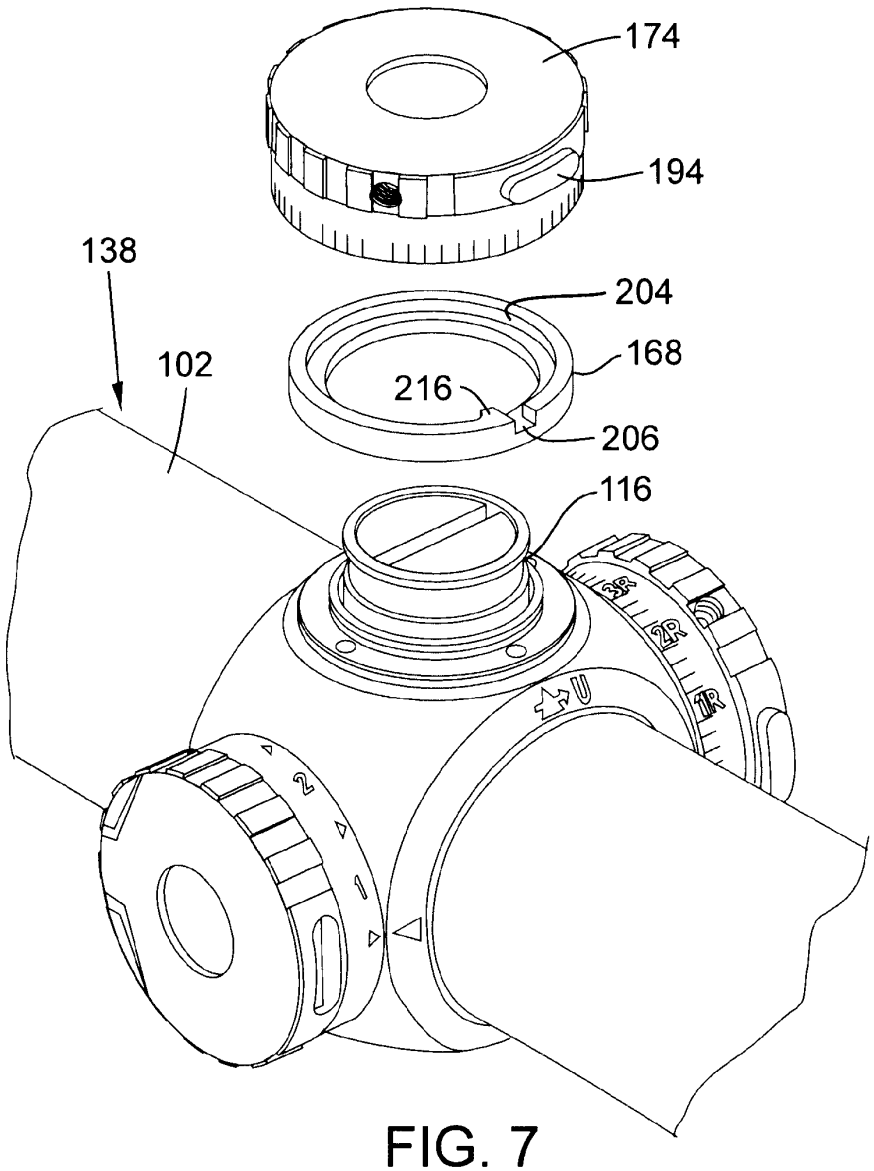

FIG. 7

LOCKING ADJUSTMENT DEVICE

TECHNICAL FIELD

The field of the present disclosure relates generally to rotating adjustment mechanisms, and in particular, to locking adjustment knobs for actuating optical or electrical elements such as an elevation adjustment knob for a sighting device, such as a riflescope, a telescope, other aimed optical device.

BACKGROUND

Sighting devices such as riflescopes have long been used in conjunction with weapons and firearms, such as rifles, handguns, and crossbows, to allow a shooter to accurately aim at a selected target. Because bullet and arrow trajectory, wind conditions, and distance to the target can vary depending upon shooting conditions, quality sighting devices typically provide compensation for variations in these conditions by allowing a shooter to make incremental adjustments to the optical characteristics or the aiming of the sighting device relative to the weapon surface on which it is mounted. These adjustments are known as elevation and windage adjustments, and are typically accomplished by lateral movement of an adjusting member, such as a reticle located within the riflescope, as shown in U.S. Pat. No. 3,058,391 of Leupold, or movement of one or more lenses within a housing of the riflescope, as shown in U.S. Pat. Nos. 3,297,389 and 4,408,842 of Gibson, and U.S. Pat. No. 7,827,723 of Zaderey et al.

The shooter typically makes such adjustments using rotatable adjustment knobs to actuate the adjustable member of the sighting device. Rotatable knobs may also be used to adjust other features of riflescopes, binoculars, spotting scopes, or other suitable optical devices, such as parallax, focus, illumination brightness, or other suitable features. Although the rotatable knobs are described in relation to use with sighting devices, rotatable knobs may be used to adjust an adjustable portion of other devices, and may include volume control knobs, channel selection knobs, radio station selection knobs, and other suitable knobs.

Automatically locking devices with rotatable adjustment knobs are known. For example, U.S. patent application Ser. No. 12/938,981 filed Nov. 3, 2010 and published as US 2011/0100152 A1, which is incorporated herein by reference describes an automatically locking adjustment device. The locking device includes a rotatable knob with two buttons on opposite sides of the knob that must be squeezed together to unlock the knob for rotation and thereby enable a desired adjustment. When the buttons are released, the knob is immediately locked at its current rotational position. One drawback of this adjustment device is its relative complexity and attendant expense of manufacture. The squeezing pressure required to unlock the knob for rotation may also make it more difficult to effect multiple fine rotation adjustments in the course of an aiming operation, when inadvertent rotation of the knob is less of a concern.

The present inventor has, thus, recognized a need for an improved locking adjustment mechanism for preventing inadvertent adjustment of an optical or electrical setting of a device.

SUMMARY

An apparatus is disclosed for a locking adjustment device that may be used to change an adjustable setting of a riflescope or other device. The locking adjustment device automatically locks in a home position or baseline position to provide expedient feedback regarding an adjustment position of the adjustable setting. According to one embodiment, the locking adjustment device includes a guideway having a curved slide surface portion extending around an axis, and a notch formed in a first end of the curved slide surface portion and extending in a radial direction relative to the axis. The device further includes a knob mountable over the guideway for rotation about the axis when the adjustment device is installed on the riflescope or other aiming device. The knob carries a guide tab that extends inwardly within the knob toward the aiming device and is slidably received in the guideway. The guide tab is biased in the radial direction relative to the knob so as to urge at least a portion of the guide tab into the notch when the knob is rotated to a locked position at which the guide tab is aligned with the notch and thereby prevent the knob from rotating. The device further includes a button carried by the knob for rotation therewith, wherein the button is operatively associated with the guide tab and manually depressible to urge the guide tab out of the notch and allow for rotation of the knob about the axis.

In another embodiment, the device may include a second curved slide surface portion extending around the axis and linked to the first curved slide surface via a transition section of the guideway, such as a ramp. The guideway may further include a second end on the second curved slide surface defining a stop that blocks the guide tab and limits rotation of the knob beyond the second end. In such embodiments, the guide tab may slide along the guideway and travel between the curved slide surface and the second curved slide surface via the transition section.

In some embodiments, the device may include an indicator unit coupled to the guide tab and visible on a surface of the knob, and a biasing element operatively associated with the guide tab and the indicator unit to urge movement of the indicator unit. The indicator unit may be configured to move between a first position when the guide tab is aligned with the notch, a second position when the guide tab is positioned along the curved slide surface away from the notch, and a third position when the guide tab is positioned along the second curved slide surface.

Additional aspects and advantages will be apparent from the following detailed description of preferred embodiments, which proceeds with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a locking adjustment device, according to one embodiment;

FIG. **2** is a cross-sectional view of the locking adjustment device of FIG. **1** taken along line **2**-**2**;

FIG. **3** is an exploded view of the locking adjustment device of FIG. **1**;

FIG. **4** is a top view of a guide ring of the locking adjustment device of FIG. **1**;

FIG. **5** is an exploded view of the guide ring, a guide tab, and a button of the locking adjustment device of FIG. **1**;

FIG. **6**A is a perspective view of the locking adjustment device of FIG. **1** when the locking adjustment device is in a locked position;

FIG. **6**B is a perspective view of the locking adjustment device of FIG. **1** in an unlocked position and in a first rotation about a rotational axis;

FIG. **6**C is a perspective view of the locking adjustment device of FIG. **1** in an unlocked position and in a second rotation about the rotational axis; and

FIG. **7** is an exploded view of a locking adjustment device, according to another embodiment.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to the drawings, this section describes particular embodiments and their detailed construction and operation. Throughout the specification, reference to "one embodiment," "an embodiment," or "some embodiments" means that a particular described feature, structure, or characteristic may be included in at least one embodiment. Thus appearances of the phrases "in one embodiment," "in an embodiment," or "in some embodiments" in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the described features, structures, and characteristics may be combined in any suitable manner in one or more embodiments. In view of the disclosure herein, those skilled in the art will recognize that the various embodiments can be practiced without one or more of the specific details or with other methods, components, materials, or the like. In some instances, well-known structures, materials, or operations are not shown or not described in detail to avoid obscuring aspects of the embodiments.

FIGS. **1-5**, **6**A, **6**B, and **6**C illustrate various detailed views of a locking adjustment device **100** that may be used to change an adjustable setting of a riflescope **138** or other aiming device and that automatically locks in a baseline or "home" position to provide expedient feedback regarding an adjustment position of the adjustable setting, according to one embodiment. With reference to FIGS. **1-2**, locking adjustment device **100** includes a knob **174**, where adjustments may be made by rotation of knob **174** about a rotational axis **124** extending outwardly from riflescope **138**. Knob **174** includes a depressible button **194** operatively coupled to an indicator unit **196** (resting in a slot **244**) and an internal guide tab **198** (FIG. **2**). When locking adjustment device **100** is in a locked position, button **194**, indicator unit **196**, and guide tab **198** may be at a first position, where button **194** protrudes outwardly from knob **174** and indicator unit **196** is radially extended in relation to axis **124**. Knob **174** is unlocked by depressing button **194**, thereby transitioning button **194** and indicator unit **196** to a second position that indicates knob **174** is unlocked and manually rotatable about axis **124**.

The following describes further detailed aspects of this and other embodiments of the locking adjustment device **100**. In the following description of the figures and any example embodiments, reference may be made to using the locking adjustment device disclosed herein to actuate an adjustable member of a sighting device on a weapon or firearm, such as for making elevation and windage adjustments. It should be understood that any such references merely refer to one prospective use for such a locking adjustment device and should not be considered as limiting. Other uses for locking adjustment devices with the characteristics and features described herein are possible, including use in other mechanical or electrical devices for making adjustments, such as to a volume, channel, or station setting, or other suitable mechanical, electrical, optical, or electronic adjustments. Still other uses not specifically described herein may be possible. In addition, although the following description is made with reference to a single locking adjustment device, the riflescope or other device may include multiple such locking adjustment devices.

With reference to FIGS. **1-3**, locking adjustment device **100** is mounted to a main tube **102** of riflescope **138**. Within main tube **102**, at least one adjustable element, such as a reticle, lens assembly, or other optical or electrical elements, may be movably mounted in a substantially perpendicular orientation relative to a longitudinal tube axis **104**. Main tube **102** further includes a seat **106**, which has a bore **108** sized to receive locking adjustment device **100**. Bore **108** may include threads **110** formed on an interior wall or shoulder of bore **108** that may mate with corresponding threads **112** on a retaining ring **114** or another structure of locking adjustment device **100**, such as a spindle **116**, to secure locking adjustment device **100** to main tube **102** when locking adjustment device **100** is installed. Bore **108** further includes a slot or aperture **118** formed at a base **120** and sized to receive a threaded plunger **122** via an end **126** of plunger **122**. Plunger **122** includes threads **128** sized to mesh with interior threads **130** on an interior bore **132** of spindle **116** so that plunger **122** may be threadably coupled to spindle **116**.

Plunger **122** extends into main tube **102** and is constrained from rotating about axis **124** so that rotation of spindle **116** (into which plunger **122** is threaded) is translated into linear motion of plunger **122** along axis **124**, thereby adjusting a position of the adjustable element within main tube **102**. This arrangement is simply one configuration for an adjustment core and it should be understood that there are many other possible configurations for main tube **102** and for the accompanying structures described above, such as the riflescopes described in U.S. Pat. Nos. 6,279,259, 6,351,907, 6,519,890, and 6,691,447. In other embodiments, the adjustment core may have different mechanical arrangements for effecting a mechanical, electrical, and/or optical adjustment.

Spindle **116** includes a lower base portion **134** and an upper neck portion **136**, which preferably is smaller in diameter than lower base portion **134**. Retaining ring **114** surrounds spindle **116** and retains spindle **116** against seat **106** of the riflescope **138**. Retaining ring **114** includes exterior threads **112** sized to mesh with threads **110** on bore **108**. Thus, spindle **116** is captured against main tube **102** and allowed to rotate about axis **124**, but is constrained from traveling along axis **124** by retaining ring **114**, which is threaded into bore **108** of main tube **102**. Retaining ring **114** includes a pair of blind bores **142** sized to fit a spanner wrench for threading and tightening retaining ring **114** onto spindle **116** or into bore **108**, or both.

In some embodiments, exterior threads **112** may be omitted and retaining ring **114** may instead be affixed to bore **108** such as by a press-fit or a weld, or by another fastening mechanism, such as a bayonet mount. In the embodiment illustrated, a washer **144** is sandwiched between lower base portion **134** of spindle **116** and base **120** of seat **106**. Washer **144** may be made from any suitable wear-resistant material, such as nylon, polytetrafluorethylene (PTFE) polymer (e.g., Teflon®), or other suitable material.

Locking adjustment device **100** may include a click mechanism **146** to provide tactile and/or audible feedback to the user when knob **174** of locking adjustment device **100** is rotated. Click mechanism **146** includes a click ring **148** interposed between a shoulder **150** of the lower base portion **134** of spindle **116** and retaining ring **114**. Click ring **148** includes a grooved surface **152** facing spindle **116**. Grooved surface **152** includes regularly spaced apart features, which preferably include splines or a series of evenly spaced vertical grooves or ridges. Other engagement features may include a series of detents, indentations, apertures, or other suitable features. Click mechanism **146** further includes a click pin **154** with a ramped surface **156** configured to engage the regularly spaced apart features of grooved surface **152**. Click pin **154** is housed within a bore **158** in spindle **116** that has an open end facing grooved surface **152**. A spring **160**, or other biasing element, urges click pin **154** to extend outwardly from within bore **158** and engage grooved surface **152** of click ring **148**. In opera-

tion, rotational movement of knob **174** about axis **124** causes click pin **154** to move out of contact with one groove and into a neighboring groove, thereby producing a click that is either audible, tactile, or both. Each click may coincide with an adjustment amount to alert the user about the extent of an adjustment being made. Click mechanism **146** continues clicking as long as knob **174** is rotated.

In some embodiments, locking adjustment device **100** may include sealing devices and other features to minimize entry of foreign materials, such as dust, dirt, or other contaminants, to help prevent rust, wear, or other damage to the components of locking adjustment device **100**. The seals may be hermetic seals and the interior of riflescope **138** may be filled with a dry gas, such as nitrogen or argon, to help prevent fogging that may otherwise be caused by condensation of moisture vapor on surfaces of lenses and other optical elements within riflescope **138**. For example, in some embodiments, locking adjustment device **100** may include a pair of contaminant seals **162**, **164** sandwiched between retaining ring **114** and spindle **116** to seal any openings or gaps between the two components. Contaminant seals **162**, **164** are preferably o-rings formed of rubber or another elastomeric material, but may be formed by any other suitable sealing material, such as plastic, nylon, or PTFE polymers (e.g., Teflon®).

Locking adjustment device **100** further includes a guide ring **168** attached along a stepped portion **170** of an upper necked portion **172** of retaining ring **114**. Guide ring **168** is preferably press fit around retaining ring **114** such that it rests flush against stepped portion **170** and upper necked portion **172**. In some embodiments, guide ring **168** may be welded, threaded, or adhered by an adhesive substance to retaining ring **114**. In other embodiments, guide ring **168** may be integrated with or formed in retaining ring **114** or main tube **102**. Particular aspects and features of guide ring **168** are described below in further detail with reference to FIGS. **4** and **5**.

Locking adjustment device **100** includes knob **174** mountable over guide ring **168** and spindle **116** for rotation about axis **124** when locking adjustment device **100** is installed on riflescope **138**. Knob **174** includes a retaining cap **176** and a dial **178**. Retaining cap **176** includes a cylindrical gripping surface **180** that may be notched, fluted, knurled, or otherwise textured to provide a surface for the user to grip when manually rotating knob **174**. Dial **178** may be supplied with a fine scale composed of parallel longitudinal indicia **182** spaced apart around the circumference of dial **178** to facilitate fine adjustments. Retaining cap **176** and dial **178** may be fabricated as a single unitary part or may be formed from two separate components that are coupled together, such as via mating threads.

Knob **174** includes a threaded bore **184** sized to receive a threaded set screw **186**. It should be understood that any number of bores, with a corresponding number of set screws, may be provided on knob **174**. Set screw **186** rigidly couples knob **174** to a collar **188** that is press-fit onto upper neck portion **136** of spindle **116** so that knob **174** and spindle **116** rotate together as a unit. In other embodiments (not shown), collar **188** may be omitted and knob **174** may be directly coupled to spindle **116** by set screws **186** or otherwise. A tool, such as a hex key, can be used to tighten set screw **186** such that set screw **186** bears against collar **188**. Similarly, the tool can be used to loosen set screw **186** so that knob **174** and/or dial **178** can be rotated relative to spindle **116** about axis **124** or removed and replaced with a different knob **174**, if desired. In other embodiments (not shown), knob **174** is coupled or releasably coupled to spindle **116** in a manner other than by set screws **186**. The combination of collar **188** and set screws **186**, in conjunction with a flanged portion **190** on collar **188**, help prevent knob **174** from lifting upward in a direction along axis **124**.

Knob **174** may carry a button **194** and an indicator unit **196** for rotation therewith. Button **194** is operably associated with a guide tab **198** and manually depressible to urge guide tab **198** out of a locked position and thereby allow knob **174** to be manually rotated about axis **124** away from the locked position. The cross-sectional view in FIG. **2** illustrates the position of guide tab **198** after knob **174** has been rotated once about axis **124**. Further detailed aspects associated with the operation of knob **174**, button **194**, indicator unit **196**, and guide tab **198** are discussed below with reference to FIGS. **5**, **6**A, **6**B, and **6**C.

FIG. **4** illustrates a top view of guide ring **168** and FIG. **5** illustrates an exploded view of guide ring **168**, button **194**, and guide tab **198**. With reference to FIGS. **4** and **5**, guide ring **168** includes a guideway **202** having a curved slide surface **204** extending around axis **124** (FIG. **2**) and a notch **206** formed in a first end **208** of curved slide surface **204** and extending in a radial direction relative to axis **124**. Guideway **202** may include a second curved slide surface **210** also extending around axis **124** and linked or connected to curved slide surface **204** via a transition section **212** of guideway **202**. In the embodiment illustrated, transition section **212** is in the form of a linear ramp between a second end **238** of first curved slide surface **204** opposite first end **208** and a first end **240** of the second curved slide surface **210**. In other embodiments (not shown) transition section **212** may have a different shape. Second curved slide surface **212** includes a second end **214** opposite first end **240**. In other embodiments, guideway **202** may form a spiral around axis **124**, with curved slide surface **204** disposed at a first radial position from axis **124** and second curved slide surface **210** disposed at a second radial position from axis **124**. Second end **214** defines a stop **216** that limits rotation of knob **174** as further described below.

In the embodiments illustrated, curved slide surfaces **204**, **210** each face axis **124** (FIG. **2**). In other embodiments (not shown), curved slide surfaces **204**, **210** might not face axis **124**. In some embodiments, curved slide surfaces may include rails, tracks, or other structures that may provide a bearing and guide surface for guide tab **198** or another "follower" device.

It should be understood that in other embodiments, any number of curved slide surfaces may be added to guideway **202**, as desired, for allowing a greater or lesser degree of revolution of knob **174**, such as three, four or five revolutions. In such embodiments, stop **216** may be defined at an end on the last of the curved slide surfaces opposite first end **208** on guideway **202**.

Referring now to FIG. **5**, knob **174** carries button **194** and guide tab **198** for rotation therewith, guide tab **198** extending inwardly within knob **174** toward riflescope **138**. Guide tab **198** includes a tubular upper portion **218** extending from a top surface **220** of a substantially planar body **222**, and a tabbed end **224** extending from an opposing bottom surface **226** of body **222**. Guide tab **198**, via tabbed end **224**, is slidably received by guideway **202** when locking adjustment device **100** is installed on riflescope **138**. Guide tab **198** is configured to travel along guideway **202**, riding against curved slide surface **204** and second curved slide surface **210** in response to rotation of knob **174**.

In some embodiments, guide tab **198** may be rigidly attached or coupled to button **194** via tubular portion **218** of guide tab **198**. Tubular portion **218** may be inserted into an opening **228** on button **194** having dimensions corresponding to tubular portion **218** and secured therein, such as by a press

fit or using an adhesive. Alternatively, tubular portion **218** and opening **228** may both be threaded so that guide tab **198** is threadably coupled to button **194**. In other embodiments, guide tab **198** and button **194** may instead be formed as a single unitary piece.

Button **194** may include a pair of openings **230** sized to interact with a pair of biasing elements **232**, such as springs. Biasing elements **232** bias button **194** and guide tab **198** in a radial direction relative to knob **174** so as to urge movement of guide tab **198** when knob **174** is rotated. In some embodiments, button **194** may further include indicator unit **196** arranged on a top surface **234** of button **194**. Preferably, indicator unit **196** has an elongate, rectangular-shaped body **236** and is formed as a single, unitary piece of button **194**. In other embodiments, indicator unit **196** may have a different shape and formed as a separate component of and thereafter attached to button **194**. Further details relating to indicator unit **196** are discussed below with reference to FIGS. **6**A, **6**B and **6**C.

The following description illustrates an example operation of the interaction between button **194**, guide tab **198**, and guideway **202**, among other components, of locking adjustment device **100**. When locking adjustment device **100** is in a locked position, guide tab **198** is aligned with and seated in notch **206**, thereby constraining knob **174** and preventing inadvertent rotation of knob **174** relative to riflescope **138**. In this position, biasing elements **232** urge at least a portion of guide tab **198**, such as tabbed end **224**, into notch **206**.

To unlock knob **174**, button **194** is depressed inwardly toward axis **124** to urge guide tab **198** out of notch **206** and onto curved slide surface **204** near first end **208**. From this position, knob **174** may be manually rotated about axis **124** away from the locked position. As knob **174** is rotated (i.e., as the user is making a desired adjustment), guide tab **198** rides away from first end **208** and along curved slide surface **204**. Once knob **174** has completed a rotation around axis **124**, guide tab **198** automatically transitions onto ramped transition section **212** and continues on second curved surface **210** to accommodate a second rotation of knob **174**. Depending on the shape of transition section **212**, the user may or may not feel a minor stop, bump, or other tactile sensation when guide tab **198** transitions between first and second curved surfaces **204** and **210**. The user can continue turning knob **174** until guide tab **198** hits stop **216** along second end **214** of second curved surface **210**. At that point, stop **216** blocks guide tab **198** from moving beyond second end **214**, thereby limiting further rotation of knob **174** in this direction. Knob **174** may still be rotated in an opposite direction for further fine adjustment and/or to return knob **174** to its home position where it automatically locks.

While the figures may illustrate that guideway **202** provides for slightly less than two full rotations about axis **124**, a simple alternate design of guideway **202** may accommodate two or more full rotations. For instance, guideway **202** may include a second transition section (similar to the ramped transition section **212**) on second end **214** that is linked to a third curved surface extending about axis **124**. Stop **216** may be positioned along the third curved surface at a position defining two full rotations of knob **174**. In such configuration, once guide tab **198** reaches second end **214**, guide tab **198** moves onto the second transition section and continues along the third curved surface until it reaches stop **216**. In some embodiments, the third curved slide surface (not shown) may completely extend about axis **124** to provide for an additional rotation of knob **174**.

In some embodiments, transition section **212** may instead be a stepped transition section. In such embodiments, button **194** may be further depressible such that it urges guide tab **198** out of notch **206** when button **194** is first depressed and, once knob **174** has made one rotation about axis **124**, button **194** may be further depressed to urge guide tab **198** over the stepped transition section and onto second curved slide surface **210**. Similarly, button **194** may be retractable, such as using biasing elements **232**, so that button **194** automatically retracts when guide tab **198** transitions from second curved slide surface **210**, over the stepped transition section, and back onto curved slide surface **204**.

Guide ring **168**, button **194**, and guide tab **198** are preferably constructed of or coated with a rigid, durable, and wear-resistant material, such as nylon, PTFE polymers (e.g., Teflon®), steel, aluminum, or other suitable material, to withstand wear due to friction as guide tab **198** slides along or within guide ring **168**. In other embodiments, button **194** may be manufactured from one material and guide tab **198** may be manufactured from a different material. For instance, since button **194** may not experience as much wear due to friction as compared to guide tab **198**, button **194** may be constructed from anodized aluminum or other material to provide a balance of component weight, wear-resistance, and strength. On the other hand, since the sliding action of guide tab **198** on or along the guide ring **168** will wear guide tab **198** over time, guide tab **198** may be manufactured from or coated with a different material, such as stainless steel, for strength, wear-resistance, and corrosion-resistance.

FIGS. **6**A, **6**B, and **6**C illustrate example embodiments of knob **174** carrying button **194** with indicator unit **196** for indicating whether knob **174** is in a locked position and also for indicating the number of rotations of knob **174**. Simply by considering the relative positions of indicator unit **196** and button **194**, the user is able to quickly determine the state of knob **174** (i.e., whether it is locked and/or the number of rotations about axis **124**). Knob **174** includes a central recess **200** and a slot **244** extending in a radial direction relative to axis **124**. Slot **244** is sized and dimensioned to slidably receive indicator unit **196** such that at least a portion of indicator unit **196** is visible on a top surface **246** of knob **174**. Knob **174** further includes an aperture **248** on grip surface **180** sized and dimensioned to slidably receive button **194**.

In an example operation, when knob **174** is in a locked position (during which guide tab **198** aligns with notch **206**), button **194** and indicator unit **196** may be in a first position, such as illustrated in FIG. **6**A. In this first position, button **194** extends outwardly from grip surface **180** and indicator unit **196** is in a retracted state in relation to central recess **200**.

To unlock knob **174**, the user may depress button **194** inwardly toward knob **174** until it is substantially flush in relation to grip surface **180**. Depression of button **194** contracts biasing elements **232** and urges guide tab **198** out of alignment with notch **206** and onto curved slide surface **204**, as previously described. Depression of button **194** and guide tab **198** in turn urges indicator unit **196** to move from the first position to a second position, where indicator unit **196** moves toward central recess **200** until it is substantially flush in relation to central recess **200**, such as illustrated in FIG. **6**B. This second position indicates that knob **174** is unlocked and may be manually rotated about axis **124**. As knob **174** is rotated, guide tab **198** slides on first curved slide surface **204** and button **194** and indicator unit **196** remain in this second position while guide tab **198** is on first curved slide surface **204** (i.e., throughout the first rotation of adjustment).

During the second rotation of knob **174**, guide tab **198** transitions from curved slide surface **204** to second curved slide surface **210** via transition section **212**, as previously described. Since guide tab **198** is coupled to button **194** and

indicator unit **196**, guide tab **198** draws button **194** inwardly toward axis **124**, which simultaneously draws indicator unit **196** into central recess **200** on knob **174**. Biasing elements **232** are further contracted in this third position. This third position indicates that knob **174** is unlocked and is in a second rotation about axis **124**. As knob **174** is rotated, button **194** and indicator unit **196** remain in this third position while guide tab **198** is on second curved slide surface **210** (i.e., throughout the second rotation of adjustment).

Reversing rotation of knob **174** at any point causes the same functions to be performed in reverse. For example, when knob **174** reverts from the third position to the second position, (i.e., when guide tab **198** transitions from second curved slide surface **210** to first curved slide surface **204**), button **194** and indicator unit **196** retract back to their substantially flush positions, as previously described with respect to the second position. Biasing elements **232** also expand to help urge button **194**, indicator unit **196**, and guide tab **198** back into these second positions. As knob **174** is turned back into its locked position, guide tab **198** is urged into notch **206** by biasing elements **232** to automatically lock knob **174**, and button **194** and indicator unit **196** are expanded to their locked positions, where button **194** extends outwardly from gripping surface **180** and indicator tab **196** is in a retracted state from central recess **200**.

In some embodiments where locking adjustment device **100** is configured to allow more than two rotations of knob **174**, indicator unit **196** can be urged further into central recess **200** and button **194** urged further into aperture **248** in a similar fashion as described above to indicate that knob **174** is in a third rotation about axis **124**. In other embodiments, knob **174** may include a scale or other marking near or next to indicator unit **196**, such as a number scale with position markings reading 0, 1, and 2, to provide additional visual feedback to the user regarding the position of knob **174**. For instance, when knob **174** is in a locked position, indicator unit **196** may be aligned with the 0 marking. When knob **174** is unlocked and in its first or second rotation, indicator unit **196** may align with the 1 or 2 marking, respectively.

In an alternate embodiment, the arrangement of button **194**, indicator unit **196**, and guide tab **198** may be different. For instance, button **194** may instead be arranged on top surface **246** and moveable in an upward/downward direction relative to riflescope **138** (e.g., along a parallel axis in relation to axis **124**). Indicator unit **196** may be arranged along grip surface **180** and coupled to guide tab **198** and button **194** such that it is moveable in a similar fashion as previously described to indicate whether knob **174** is in a locked position and/or the number of rotations of knob **174**. In addition, guide tab **198** may be arranged on an end of button **194** and also moveable in an upward/downward direction. In such a configuration, biasing elements **232** may be arranged to instead extend along the upward/downward axis to bias guide tab **198**. Button **194**, indicator unit **196**, and guide tab **198** may be positioned and move between the first, second, and third positions in a similar fashion as previously described.

In addition, curved slide surfaces **204**, **210** may be arranged on different planes of guide ring **168** in relation to one another. For instance, curved slide surface **204** may be arranged proximal to knob **174** and second curved slide surface **210** may be arranged proximal to riflescope **138**, such that guideway **202** spirals downward toward riflescope **138** from curved slide surface **204** to second curved slide surface **210**. Guide ring **168** may include a raised pedestal portion above curved slide surfaces **204**, **210** and having a slot or opening sized to receive guide tab **198**. When guide tab **198** is positioned in the slot, locking adjustment device **100** is in a locked position (similar to when guide tab **198** was aligned with notch **206**). The raised pedestal portion may include a downward sloping ramped portion linking to curved slide surface **204** to provide for movement of guide tab **198** from the raised pedestal portion to guideway **202**.

In an example operation, depression of button **194** contracts biasing element **232** and urges guide tab **198** out of the slot in the raised pedestal portion, down the ramped portion, and onto curved slide surface **204**. As knob **174** is rotated beyond the first rotation about axis **124**, guide tab **198** transitions onto second curved slide surface **210** and draws button **194** inwardly, which simultaneously moves indicator unit **196** along grip surface **180** and further retracts biasing elements **232**. Button **194** and indicator unit **196** remain in this position while guide tab **198** is on second curved slide surface **210**.

Reversing rotation of knob **174** at any point causes the same functions to be performed in reverse. For instance, when guide tab **198** transitions from second curved slide surface **210** back to first curved slide surface **204**, button **194** and indicator unit **196** may retract back to their substantially flush positions and biasing elements **232** expand to help urge button **194**, indicator unit **196**, and guide tab **198** back into these positions. As knob **174** is turned back into its locked position, guide tab **198** moves up the ramped portion and is urged back into the slot in the raised pedestal portion by biasing elements **232** to automatically lock knob **174**. Similar to the previously described embodiments, button **194** and indicator unit **196** then return to their locked positions. Other embodiments and arrangements for button **194**, indicator unit **196**, and guide tab **198** may be possible.

FIG. **7** illustrates another embodiment of locking adjustment device **100** where guide ring **168** includes only one curved slide surface **204** to provide for a single rotation of knob **174** about axis **124**. Guide ring **168** includes notch **206** and stop **216** both are arranged along curved slide surface **204**. Guide ring **168** may be attached to spindle **116** in a similar fashion as previously described and knob **174** may include similar components as described in other embodiments, including button **194** operably associated with the guide tab (not shown). In some embodiments, button **194** may not include a separate indicator unit **196**. Instead, button **194** may perform a similar indication function.

For instance, when knob **174** is in a locked position, the guide tab is aligned in notch **206** and button **194** is extended outwardly in relation to gripping surface **180** of knob **174**. The extended state of button **194** indicates that knob **174** is in a locked position and cannot be rotated. Depressing button **194** inwardly urges the guide tab out of notch **206** and onto curved slide surface **204** for rotation thereon. Knob **174** may now be manually rotated about axis **124** to make desired adjustments. The depressed state of button **194** indicates to the user that knob **174** is unlocked and may be freely rotated about axis **124**. In a similar fashion as previously described, reversing the rotation of knob **174** causes the same functions to be performed in reverse. Knob **174** automatically locks, and button **194** automatically extends from gripping surface **180**, when the guide tab is urged back into notch **206**.

It will be obvious to those having skill in the art that many changes may be made to the details of the above-described embodiments without departing from the underlying principles of the invention. The scope of the present invention should, therefore, be determined only by the following claims.

The invention claimed is:

1. A locking adjustment device for adjusting a setting of a riflescope or other aiming device, comprising:

a guideway including a slide surface extending around a rotational axis, and a notch formed in the slide surface;

a knob mountable over the guideway for rotation about the rotational axis when the adjustment device is installed on the aiming device;

a guide tab carried by the knob for rotation therewith and slidably received in the guideway when the adjustment device is installed on the aiming device, the guide tab being movable relative to the knob and biased against the slide surface so as to urge at least a portion of the guide tab toward the notch when the knob is rotated to a locked position at which the guide tab is aligned with the notch, thereby preventing inadvertent rotation of the knob relative to the aiming device from the locked position; and

a button carried by the knob for rotation therewith, the button operably associated with the guide tab and movable therewith relative to the knob when the button is manually depressed to urge the guide tab out of the notch and thereby allow the knob to be manually rotated about the rotational axis away from the locked position.

2. The locking adjustment device of claim **1**, wherein the guideway includes a second slide surface extending around the axis and linked to the slide surface via a transition section wherein the guide tab is movable along the second slide surface and the transition section when the knob is rotated.

3. The locking adjustment device of claim **2**, wherein the second slide surface includes a stop that blocks the guide tab to limit rotation of the knob beyond the stop.

4. The locking adjustment device of claim **3**, wherein the guideway is spiraled and the slide surface is at a first radial position from the rotational axis and the second slide surface is at a second radial position from the rotational axis.

5. The locking adjustment device of claim **1**, further comprising an indicator unit carried by the knob and movable relative to the knob, the indicator unit visible on a surface of the knob, wherein the indicator unit is at a first position when the guide tab is aligned with the notch and at a second position when the guide tab is positioned along the slide surface away from the notch.

6. The locking adjustment device of claim **5**, wherein the indicator unit is coupled to the guide tab and the locking adjustment device further comprises a biasing element operatively associated with the guide tab and the indicator unit to urge movement of the indicator unit from the second position to the first position.

7. The locking adjustment device of claim **5**, wherein the indicator unit is slidably received in a slot arranged on the surface of the knob.

8. The locking adjustment device of claim **3**, further comprising:

an indicator unit coupled to the guide tab and visible on a surface of the knob; and

a biasing element operatively associated with the guide tab and the indicator unit,

wherein the indicator unit is at a first position when the guide tab is aligned with the notch, a second position when the guide tab is positioned along the slide surface away from the notch, and a third position when the guide tab is positioned along the second slide surface, and wherein the biasing element urges movement of the indicator unit from the third position to the second position and from the second position to the first position.

9. The locking adjustment device of claim **1**, wherein the aiming device includes a housing and the locking adjustment device further comprises:

a spindle mounted to the housing for rotation about the axis; and

a threaded plunger extending within the housing of the aiming device and threadably coupled to the spindle, wherein rotation of the spindle about the axis causes movement of the threaded plunger along the axis.

10. The locking adjustment device of claim **9**, wherein the guideway is formed along a substantially circular guide ring.

11. The locking adjustment device of claim **10**, further comprising a retaining ring surrounding the spindle for securing the spindle to the housing, wherein the guide ring is press fit to the retaining ring.

12. The locking adjustment device of claim **1**, wherein the notch extends in a radial direction relative to the rotational axis, and wherein the guide tab is biased in the radial direction.

13. The locking adjustment device of claim **12**, wherein the guide tab extends inwardly within the knob toward the aiming device.

14. The locking adjustment device of claim **1**, wherein the guideway comprises a channel.

15. The locking adjustment device of claim **1**, wherein a radial distance from the guide tab to the rotational axis changes when the button is depressed.

16. The locking adjustment device of claim **1**, wherein the guide tab automatically transitions from the slide surface into the notch when the knob is rotated to the locked position.

17. The locking adjustment device of claim **1**, wherein the knob further includes a scale comprising indicia spaced apart on a circumference of the knob to facilitate fine adjustments.

18. The locking adjustment device of claim **1**, wherein the locked position corresponds to a baseline position of the adjustable setting.

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